An XCAL Evaluation of TMI Brightness Product using GMI

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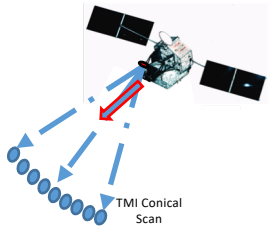
ABSTRACT

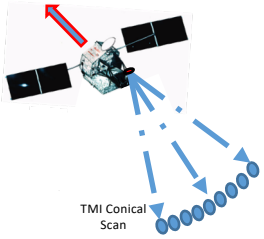
This poster presents results of an inter-satellite radiometric calibration between the TRMM Microwave Imager (TMI) and the GPM Microwave Imager (GMI) that occurred during the 15 month overlap between GMI and TRMM. Previously, the XCAL "double difference" procedure was used to determine calibration biases between the TMI and GMI channels. This paper extends the previous work and provides an in-depth look into the effects of TRMM "yaw flip" maneuvers.

TRMM CONFIGURATION

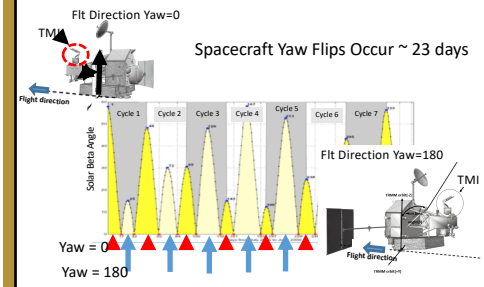
YAW = 0 & TMI LOOKING FORWARD



YAW = 180 & TMI LOOKING AFT



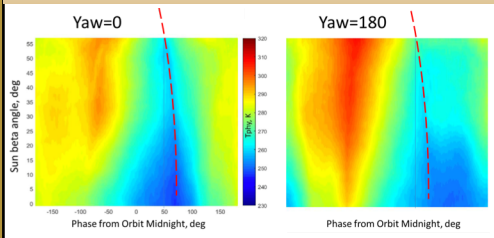
TMI YAW FLIPS



EMISSIVE REFLECTOR BRIGHTNESS TEMP CORRECTION

- The TMI 1B11 V8 Brightness Temp Product incorporated an emissive reflector correction
- ΔTb = emissivity * (Reftr Phy Temp)
  - Reftr Phy Temp was derived using single difference between measured and modeled Tb's
  - Reftr Phy Temp varies over the 90 min orbit as a function of solar beta angle and the orbit phase since eclipse

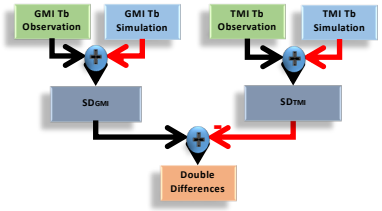
DERIVED TMI REFLECTOR PHYSICAL TEMPERATURE



XCAL ANALYSIS OF TMI/GMI MEASUREMENTS WITH YAW FLIPS

GMI/TMI TB VALIDATION: DOUBLE DIFFERENCES

✓Follow-on Global Precipitation Mission (GPM) provided 13 month overlap



$SD_{GMI}\ T_b = (T_{b\_GMI\text{-}obsV5} - T_{b\_GMI\text{-}sim})$

$SD_{TMI}\ T_b = (T_{b\_TMI\text{-}obsV8} - T_{b\_TMI\text{-}sim})$

$DD = SD_{GMI} - SD_{TMI}$

GMI & TMI IMAGERS CHANNELS

	TMI			GMI			
	Channels	Central Freq. (GHz)	BW (MHz)	Channels	Central Freq. (GHz)	BW (MHz)	
	T1	10.65 V	100	G1	10.65 V	100	
	T2	10.65 H	100	G2	10.65 H	100	
*	T3	19.35 V	500	G3	18.70 V	200	
	T4	19.35 H	500	G4	18.70 H	200	delta = 0.65 GHz
	T5	21.30V	200	G5	23.80 V	400	
	T6	37.00V	2000	G6	36.64 V	1000	delta = 2.5 GHz
	T7	37.00 H	2000	G7	36.64 H	1000	
	T8	85.50 V	3000	G8	89.00 V	6000	
	T9	85.50 H	3000	G9	89.00 H	6000	delta = 3.5 GHz

* Significant radiometer channel differences

DATA AND MODEL

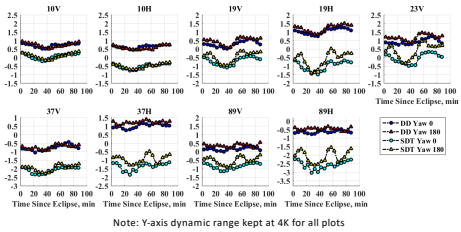
- GMI V05A Base
- TMI TRMM008 (1B11, V05A)
- Period: 03/2014-04/2015
- Matchups: ~3.5 million with 0.25 deg resolution
- Ancillary data: GDAS
- RTM: RSS surface emissivity model and Rosencrantz atmospheric absorption model
- Purpose: to investigate the yaw flip impact on instrument measurements

XCAL Procedure

- After collecting 129,538 matchups, corresponding modeled Tb's are calculated
- Single difference of TMI (SDT) is: $(Tb_{obs} - Tb_{mod})_{TMI}$;
- Single difference of GMI (SDG) is: $(Tb_{obs} - Tb_{mod})_{GMI}$
- The double difference (DD) is the difference between SDT and SDG:

  $DD = (Tb_{obs} - Tb_{mod})_{TMI} - (Tb_{obs} - Tb_{mod})_{GMI}$
  - DD's and SDT's are stratified into time since eclipse from 0 to 90 min
  - Solar beta angles are divided into six groups, each group range 10 deg
    - Negative beta angle is for yaw 180 and positive for yaw 0

DD for yaw 0 and 180 averaged over full solar beta angles

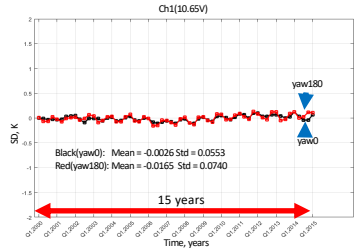


Note: Y-axis dynamic range kept at 4K for all plots

- TMI Channel mean DD biases (avg over time since eclipse) for all channels and yaw=0 & =180
- In the mean, the differences between two yaws are negligible

	10V	10H	19V	19H	23V	37V	37H	89V	89H
Yaw 0	0.74	0.65	0.31	1.06	0.95	-0.75	1.01	0.17	-0.64
Yaw 180	0.76	0.61	0.50	1.26	1.21	-0.72	1.22	0.38	-0.45
Diff	0.02	-0.04	0.19	0.20	0.26	0.03	0.21	0.21	0.19

TMI V8 Tb Stability (yaw 0 & 180), 2000 - 2015



CONCLUSIONS

- Current results are in good agreement with previous XCAL inter-satellite comparisons of TMI relative to GMI
- Present results expand previous investigation into effects of spacecraft "yaw flips"
- A small orbital Tb error (~ 0.5 K pf-to-pk) was discovered
  - The root cause is likely related to errors in the derived TMI reflector physical temperature look-up table
  - Future activities will address the removal of this systemmatic calibration error
- Based upon a comparison of SD and DD biases, we conclude that GMI free from any orbital calibration error